DOCUMENT RESUME

ED 038 021 EM 007 912

AUTHOR	Longo, Alexander A.
TITLE	The Implementation of Computer Assisted Instruction in U.S. Army Basic Electronics Training. Follow-Up of a Feasibility Study.
INSTITUTION	Army Signal Center and School, Fort Monmouth, N.J.
REPORT NO	TR-69-1
PUB DATE	Sep 69
NOTE	18p.; U.S. Continental Army Command Computer Assisted Instruction Project series
EDRS PRICE	EDRS Price MF-$0.25 HC-$1.00
DESCRIPTORS	*Comparative Analysis, *Computer Assisted Instruction, Conventional Instruction, *Feasibility Studies, Military Training, Program Evaluation

ABSTRACT

A follow-up was made to a feasibility study of the use of computer assisted instruction in teaching basic electronics. The study was designed to obtain additional empirical data, collected in a real time training environment, on the effectiveness of CAI as a teaching method relative to the conventional mode of instruction (CI). Four specific objectives were set forth: (1) a comparison of the CAI group versus the CI group on two performance criteria--test achievement and time to complete course material; (2) a comparison of the two groups on four follow-up performance criteria--written/performance tests and setback/failure rates; (3) an assessment of student attitudes toward CAI; and (4) a comparison of the revised versus the feasibility study CAI material. The findings completely support the basic conclusion drawn in the feasibility study that CAI is as effective as CI in teaching basic electronics and further demonstrates the capability of CAI to reduce training time to a significant degree. (Author/JY)

ED038021

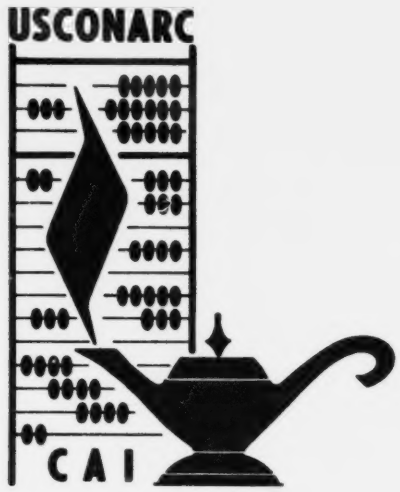
US CONTINENTAL ARMY COMMAND
COMPUTER ASSISTED INSTRUCTION PROJECT

THE IMPLEMENTATION OF COMPUTER ASSISTED INSTRUCTION IN US ARMY BASIC ELECTRONICS TRAINING

FOLLOW-UP OF A FEASIBILITY STUDY

TECHNICAL REPORT 69-1

SEPTEMBER 1969



EM 007 912

US ARMY SIGNAL CENTER AND SCHOOL

FORT MONMOUTH, NEW JERSEY

THE IMPLEMENTATION OF COMPUTER ASSISTED INSTRUCTION IN US ARMY BASIC ELECTRONICS TRAINING

FOLLOW-UP OF A FEASIBILITY STUDY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Alexander A. Longo

ED038021

September 1969

Technical Report 69-1

Approved by

Dr. Vincent P. Cieri
Technical Director

COL T. F. Schweitzer
Project Manager

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

CAI Project
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

FOREWORD

The conduct of a study such as this typically involves the concerted effort of a large number of personnel operating across varied departments and disciplines. It is no exaggeration that the success of CAI at USASCS thus far has been due to the complete dedication of all the individuals associated with this project. The contribution of the Course Development and Programming/System Operations Divisions within the CAI Project are particularly acknowledged. The assistance of the Academic Records Division of the Office of Secretary, the Radar Division and Examination Branch of the Department of Specialist Training and the Training Aids Division of the Office of Logistics at USASCS are all worthy of special note. The fruitful interaction of all the above departments is itself an achievement shared by all. If the past is any indication, the future promises a breakthrough in educational technology through the use of computer assisted instruction.

Vincent P. Cieri
Technical Director
CAI Project
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

BRIEF

This is the first in a series of studies designed to assess the effectiveness of implementing computer assisted instruction (CAI) in the US Army Basic Electronics training. The present study represents a logical follow-up to the feasibility study on computer assisted instruction in US Army Signal Center and School (USASCS). It approximates a replication of the feasibility study employing a revised CAI program with a much larger sampling of the student population entering the Common Subjects Branch of Basic Electronics at USASCS. The overall objective was to obtain additional empirical data, collected in a real time training environment, on the effectivenss of CAI as a teaching method relative to the current conventional mode of instruction (CI).

The paradigm for this study was set forth in four specific objectives: (a) a comparison of the CAI group versus the CI group on 2 performance criteria: test achievement and time to complete course material; (b) a comparison of the CAI group versus the CI group on 4 follow-up performance criteria: written/performance tests and setback/failure rates; (c) an assessment of student attitudes toward CAI; and (d) a comparison of the revised versus the feasibility study CAI material. An equivalent groups (matching by pairs) design was employed. Two matched groups with an N of 278 each were selected for evaluating the comparative effectiveness of CAI and CI. The experimental setting was the first 2 weeks of basic electronics at USASCS: Week 1 was taught separately by CAI and CI methods; Week 2, by the CI method alone.

The results comparing the CAI and CI groups on achievement and time to complete the course material indicated that the two groups were equivalent with respect to their achievement but the CAI group completed their prescribed training (Week 1) in significantly less time. In comparison with the fixed time of 11 1/4 hours of instruction for the CI group, the CAI group's mean time of 8.99 hours represented a 20.1% reduction in training time. Likewise, both groups demonstrated equivalent performance on all 4 follow-up criteria obtained at the end of Week 2 of basic electronics training: written/performance tests and incidence of setbacks/failures. The CAI group maintained a favorable disposition toward CAI over an interval of 2 weeks of instruction, despite their taking CI during the second week of training. The data also illustrated the important role which course revision has in the development and application of CAI. The overall reduction of training time of 20.1% was judged to be not only operationally and administratively but statistically significant as well.

The findings completely support the basic conclusion drawn in the feasibility study that CAI is as effective as CI in teaching basic electronics and further demonstrates the capability of CAI to reduce training time to a significant degree.

CONTENTS

	Page
Foreword	iii
Brief	v
List of Tables	viii
List of Figures	viii
Introduction	1
CAI Program Description	1
Method	3
1. Sampling	3
(a) Student Selection	3
(b) MOS Selection	4
2. Training-Testing Paradigm	4
(a) Performance Criteria	4
(b) Attitude Measure	5
3. Matching	5
4. Experimental Design	6
5. Objectives	6
Results and Analysis	7
A. CAI vs CI: Achievement/Time	7
B. CAI vs CI: Follow-up Achievement/Time	7
C. Attitudes toward CAI	8
D. Revised vs Feasibility CAI Program	9
Summary and Conclusion	11
References	12

TABLES

		Page
1.	CAI/CI Group Characteristics (15 Classes)	6
2.	CAI vs CI: Achievement/Time	7
3.	CAI vs CI: Follow-up Performance	8
4.	CAI Group Attitudes	9
5.	Revised vs Feasibility CAI: Achievement/Time	10

FIGURES

1.	Comparison of Original and Revised CAI Programs	2

The Implementation of Computer Assisted Instruction in US Army Basic Electronics Training

Follow-up of a Feasibility Study

This study is a follow-up of the feasibility study[1] on computer assisted instruction (CAI) in US Army Basic Electronics training conducted at the United States Army Signal Center and School (USASCS), Fort Monmouth, N. J. The overall purpose of the feasibility study was to provide the United States Continental Army Command objective evidence to determine the effectiveness of CAI as a medium in teaching basic electronics. It provided a comparison of student performance on 11 1/4 hours of basic electronics using CAI with equated groups taking the same subject matter under more conventional methods of instruction (instructor/TV). The results, in brief, indicated CAI to be effective, efficient and applicable for training students in basic electronics. Due to certain unavoidable constraints, however, the feasibility report emphasized the sampling limitations inherent in the study regarding both the number of subjects and the amount of material employed. Therefore, follow-up research such as the current evaluation is indicated to determine if increased confidence in the conclusions drawn in the feasibility study can be made.

The present study approximates a replication of the feasibility study employing a revised CAI program with a much larger sampling of the student population entering the Common Subjects Branch of Basic Electronics at USASCS. It provides additional empirical data, collected in a real time training environment, on the effectiveness of CAI as a teaching method relative to the current conventional mode of instruction (CI). A comparison between current CAI findings and those reported in the feasibility study is also provided. Included is evidence on achievement, time to complete course material and attitudes toward CAI.

CAI Program Description

The CAI program developed in the feasibility study represents the first 11 1/4 hours of Basic Electronics training taught at USASCS. At its inception, special attention was given to insure that the CAI course material was equivalent in content to that presented in the conventional classroom. Thus, the CAI material was developed to meet the terminal performance objectives of conventional training and, when completed, the CAI

---

[1] International Business Machines Corp. A Feasibility Study of Computer Assisted Instruction in U. S. Army Basic Electronics Training. Final Report. Contract Nr. DAAB07-67-C-0578. Gaithersburg, Md. Feb, 1968.

Original CAI Program

Segment I	Segment II	Segment III	Segment IV
Introd. to Elect.	Multimeter TS-352/U	Batteries	Resistors
L-1 Use and Purpose	L-1 Introduction	L-1 Introduction	L-1 Introduction
L-2 Survey	L-2 DC Voltage	L-2 Series Conduction	L-2 Color Code
Prac. Exer.-Survey	Prac. Exer.-	L-3 Parallel Connec-	L-3 Ohmmeter
L-3 Electron Theory	DC Voltage	tion	Prac. Exer.-
L-4 Voltage	L-3 AC Voltage	L-4 Series-Parallel	Bat./ Ohm
L-5 Resistance	L-4 DC Current	Connection	
L-6 Current			

Revised CAI Program

Segment I	Segment II	Segment III	Segment IV
Introd. to Elect.	Multimeter TS-352/U	Batteries	Resistors
L-1 Basic Concepts of Electricity	(Transfer Prac. Exer. DC Voltage to Segment III)	(Cf. Segment II)	(No Change)
L-2 Voltage, Current, Resistance			

Fig. 1. Comparison of Original and Revised CAI Programs.

course lessons were reviewed by Signal School personnel for content equivalence.

The material selected is normally taught on Thursday and Friday of the first week in the Common Subjects Branch of Basic Electronics. It includes the material in the lesson plan set 280.0-1-LP (25-38), dated Jan 1967, covering the following topics:

a. Introduction to Electricity

b. Care and Use of the Multimeter

c. Batteries

d. Resistors

e. Resistor Applications

In order to adapt the course material to CAI, the content of these topics was organized into 4 subject matter areas called course segments. These basically consist of a pretest, a series of lessons and a lesson test. (Further details pertinent to the development of the CAI material: i.e., course logic, instructional frame logic, etc., are reported in the feasibility study.)

This CAI program was administered to 18 representative students just entering basic electronics training. Analysis of the student performance records indicated the need for certain minor revisions in the CAI program. Figure 1 indicates the extent of these revisions. Most of the revision was concentrated in Segment I. This consisted in a consolidation of six lessons into two lessons. The purpose was to convert the theoretical orientation of this segment into more practical information on electricity. This modified CAI program comprised the training material administered to the CAI students during Week 1 of the follow-up study. [1]

Method

1. Sampling. The sample for this study was selected from the normal inputs of draftees and Regular Army students to the Common Subjects Branch of Basic Electronics. In order to obtain a representative sample of this population, students were selected from a number of Military Occupational Specialties (MOS) within 2 different Army career groups: Radar/Microwave Maintenance and Fixed Plant Communications Equipment Maintenance. Both the MOS and student selections were randomly obtained.

a. Student selection: Subsequent to their arrival for training, a roster of students was compiled by the Signal School Registrar. This (initial class) roster categorizes the student inputs by MOS and lists

[1] The CAI program was executed by the IBM 1500 Instructional System.

them by name according to their arrival time, which for all practical purposes is considered to be random. The first 20 students of a predesignated MOS were selected from this roster and assigned to a CAI class. The remaining students were assigned routinely to conventional instruction classes.

b. MOS selection: The type, number and input size of the MOS's in the 2 stated career groups convening for electronics training at USASCS varies weekly. These factors determined the breadth of sampling possible in the 2 given MOS series. Within these operating limits, the specific MOS from which students were drawn weekly for CAI training was selected on the basis of a table of random numbers. This student-MOS selection process was repeated for a period of 15 weeks.

2. Training-Testing Paradigm. During the course of the study (Oct. 1968 - May 1969) the 2 separate groups of incoming students reported to their respective mode of instruction (CAI/CI). Student performance (achievement and time to complete training) and attitude during the first 2 weeks of basic electronics (Phase I) comprised the extent of the comparative evaluation of these groups. Since new students require an orientation regarding their MOS, shop practices, etc., the actual extent of basic electronics training in Week 1 only amounted to 11 1/4 hours. The first week of basic electronics instruction was taught with both CAI and CI methods and represented the only major source of experimental variation between the 2 groups. Both groups were taught Week 2 of Phase I via conventional methods alone.

a. Performance criteria: On Friday of the first week of instruction, each group was administered an 85 item test designed to measure their achievement. This criterion measure was essentially the same test used in the feasibility study except for minor revision of several items. The items were selected on the basis of 2 general criteria: (1) an average item difficulty level of .65, and (2) a minimum discrimination index of .20. To increase the test's "floor" and "ceiling" a few very easy and difficult items were also included. The average difficulty level obtained was .67. The test's validity was insured by tailoring items to the course objectives and submitting them to the Department of Specialist Training, USASCS, for review and concurrence. Two measures of reliability were obtained: (1) .90 (split-half); and, (2) .87 (Kuder-Richardson). Likewise, on Friday of the second week of instruction, both groups were administered a phase examination (written and performance) covering the first 2 weeks of instruction (48 hours). Two other performance criteria were obtained directly from school records: the incidence of setbacks/failures. These 4 measures represented follow-up criteria on the relative impact of the variation in training method during Week 1.

The amount of time for the CAI and CI groups to complete their respective course material was designated as a second criterion of performance. Typically, the CI method was geared to a fixed learning schedule for all students (11 1/4 hours), whereas the CAI method provided a capability for variable learning schedules contingent on the individual's progress through the course. Calculation of the time to complete Week 1 material for the CAI students was automatically recorded in the student performance record generated by the computer.

b. Attitude measure: The CAI group was also administered an attitude questionnaire composed of 22 Likert items designed to assess their overall opinion toward CAI. The questionnaire was constructed in 2 parts: (1) a comparison of CAI with CI (11 items); and, (2) an assessment of CAI alone: e.g., hardware, software, etc. (11 items). An ordinal scale of 1-5 for each item yielded total score variations ranging from pro-CAI - neutral - pro-CI for part I; and, "favorable" - neutral - "unfavorable" for part II.

Since none of the incoming students had ever experienced CAI before, the situation-oriented nature of the items precluded any pretesting prior to CAI itself. Instead, a pre-CI vs. post-CI attitude paradigm was employed. Thus, essentially the same questionnaire was administered twice: (1) at the completion of CAI (Week I); and, (2) at the completion of CI (Week II). Only minor modifications in the instructions to adapt the questionnaire to a new situation distinguished the separate administrations. The nature of the attitude instrument and the logic of the situation itself precluded the use of other pre-post testing combinations of experimental and control groups as suggested by Campbell.(1)

3. Matching. In order to circumvent many of the administrative problems associated with the conduct of a matched groups experiment in an ongoing training environment, an "after-the-fact" matching technique was utilized.(3) The label "after-the-fact" signifies that matching of students is effected subsequent to their assignment to the different modes of instruction (not prior to it) on the basis of a matching variable already available prior to the conduct of the study. Thus, as time permits, matching is accomplished either during or after the experimental treatments are administered, without any interference with the student's ongoing training schedule.

In the present study, matching was performed on the basis of a predicted Phase I score (i.e., expected achievement in the first 2 weeks of training). A multiple regression equation, based on an N of 1500 with $R = .70$, provided the predicted scores. In turn, the scores required by the regression equation were obtained from the student personnel files which they possess at the time of their arrival for training. As explained above, the availability of various aptitude scores prior to training bypassed the need for any pretesting, and consequently permitted matching of students after classes convened. It should be noted, that the chance to obtain perfect matching of the treatment groups is increased by this procedure because a much larger pool of control group students is made available. Thus, for every subject in the CAI pool there accumulated several potential counterparts in the CI pool, which facilitated the matching process. The training of the prescribed 15 classes of students yielded 2 pools of subjects, one for each instructional method. The CI pool contained about 5 times as many subjects as the CAI pool. From these 2 treatment pools, matched pairs of students were drawn for data analysis. Selection of a matched counterpart within a given score level was done on the basis of a table of random numbers. Thus, 2 matched groups

with an N of 278 each were selected for evaluating the comparative effectiveness of CAI and CI. The matching results are contained in Table 1.

Table 1
CAI/CI Group Characteristics
(15 Classes)

		CAI		CI		t[1]	
Variables	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Pred. Ph. I[2]	278	103.30	11.40	103.30	11.40	ns[3]	ns
Age	278	20.16	2.09	20.10	1.76	ns	4.34[4]
Educ.	278	12.78	1.45	12.90	1.45	ns	ns
Elect.	278	121.40	12.05	120.62	12.26	ns	ns

[1]t test: correlated means
[2]Matching variable
[3]Difference between CAI and CI $\bar{X}$'s: nonsignificant ($p > .01$ level)
[4]Difference between CAI and CI SD's: significant ($p < .01$ level)

The 2 treatment groups were matched perfectly (on mean and variability) with respect to the matching variable (predicted Phase I score); and, were well equated on 3 other relevant parameters: age, education and background in electronics.

4. Experimental Design. The study consisted of 1 independent variable and 3 dependent variables. The independent variable was method of training, which was varied 2 ways: CAI and CI. The dependent variables were: achievement, time to complete instruction and attitude toward CAI (CAI group alone).

The method of "equivalent groups: matching by pairs design" was employed. With perfect maching, this method has the experimental effect of utilizing one group which takes 2 different methods of instruction. The t test for correlated samples was used to determine whether the mean achievement between the experimental (CAI) and control (CI) group was statistically significant or could have occurred by chance. Where percentages were employed (e.g., incidence of setbacks and failures) the chi square (X^2) for correlated proportions was used. The .01 level was set as the accepted level of significance for all the statistical analyses. (Since none of the t tests between the means were significant, further evaluation regarding the strength of the association between the independent variable (training method) and the dependent variable (scores obtained) as measured by ω^2 was not considered necessary to the data analysis). (2)

5. Objectives. The purpose of this study was set forth in 4 objectives: (a) a comparison of the CAI group versus the CI group on 2 performance

criteria: test achievement and time to complete course material (Week 1); (b) a comparison of the CAI group versus the CI group on 4 follow-up performance criteria: written/performance tests and setback/failure rates (Week 2); (c) an assessment of student attitudes toward CAI; and, (d) a comparison of the revised versus the feasibility study CAI material (Week 1).

Results and Analysis

The results relating to each of the 4 objectives are contained in Tables 2-5. These objectives will be discussed separately.

A. CAI vs CI: Achievement/Time

The results of the comparison between the CAI and CI groups on their relative achievement and time to complete Week 1 basic electronics material are included in Table 2. The 2 treatment groups exhibited equivalent

Table 2

CAI vs CI: Achievement/Time

Perform. Measure	N	CAI $\bar{X}$	CAI SD	CI $\bar{X}$	CI SD	t^1 $\bar{X}$	t^1 SD
Achiev. (Raw Scores)	278	61.92	13.25	62.44	12.84	ns[2]	ns
Time (Hrs.)	278	8.99	3.02	11.25	___[3]	(20.1% Reduction)	

[1]t test: correlated means
[2]Difference between CAI and CI $\bar{X}$'s: nonsignificant ($p > .01$ level)
[3]Fixed time for all CI S's: no variation

achievement on the 85 item criterion test which covered Week 1 material. No significant difference was observed between the 2 groups either in their mean scores or their variability in performance. However, the CAI group demonstrated a mean time of 8.99 hours to complete 11 1/4 hours of instruction. This represented a 20.1% reduction in training time in comparison with the fixed training time of 11 1/4 hours for the CI group. The lack of time variability in the CI group restricted the relative comparison of time between the 2 groups to an absolute difference measure (i. e., 20.1%).

B. CAI vs CI: Follow-up Achievement/Time

A related objective was the comparison of the 2 treatment groups on 4 follow-up measures: written/performance tests and setback/failure rates. The question raised was what impact did CAI, administered in Week 1, have on Week 2 performance? Accordingly, the follow-up measures pertain to student performance at the end of the first 2 weeks of basic electronics (Phase 1).

The results (Table 3) on all 4 criteria again indicated that the 2 treatment groups were equivalent. The differences between the 2 groups

Table 3

CAI vs CI: Follow-up Performance

Perform. Measure	N	CAI $\bar{X}$	CAI SD	CI $\bar{X}$	CI SD	t^1 $\bar{X}$	t^1 SD
Ph. I (Writ)	278	27.95	6.57	29.05	6.66	ns[2]	ns
Ph. I (Perf)	278	23.46	4.58	22.99	4.55	ns	ns
		NR		NR		X^2	
Ph. I (Setbacks)	278	44		52		ns[3]	
Ph. I (Failures	278	11		13		ns	

[1] t test: correlated means
[2] Difference between CAI and CI X's: nonsignificant ($p > .01$ level)
[3] X^2 test: correlated proportions

regarding written and performance tests (on both mean and variability) and incidence of setbacks and failures were not statistically significant at the predesignated .01 level. The written and performance results contained in Table 3 represent data on those students who completed Phase I. In those cases where students were setback and retested again, only their first score was used in the data analysis. Since the drop rate (for all reasons) prior to completing Phase I was only about 1% for both treatment pools, neither treatment sample was considered overly select with respect to the other and both were considered representative of the Phase I population. The findings for objectives A and B strongly support the conclusion drawn in the feasibility study that the CAI students performed as well as CI students but in substantially less time.

C. Attitudes toward CAI

The third basic objective of this study concerned the nature and degree of student attitudes toward CAI. Several facets of this objective were indicated earlier: (a) none of these students had ever experienced CAI prior to reporting for training at USASCS; (b) there is a basic interest in how students feel toward specific aspects of CAI and its relationship to CI; and, (c) there is a general concern, similar to the area of achievement, about the stability of student attitudes over a period of time. The logic of these problems, therefore, dictated the following directions in this part of the study: (a) only the CAI students were qualified to take the

attitude questionnaire; (b) 2 situation-oriented attitude scales: (I) comparing CAI with CI, and (II) CAI considered alone, would be preferred to one generalized attitude instrument; and, (c) a pre-CI (Week I) versus post-CI (Week II) paradigm would provide some index to the reliability of student attitudes over additional (and different) training time.

The results, both at the end of Week I (CAI) and Week II (CI) indicated that the CAI group favored CAI over CI, and were especially well disposed toward the CAI system (hardware, software, and environment). (Cf. Table 4: parts I/II of Weeks 1/2, respectively). Testing the observed results of both parts of the attitude instrument for both weeks against an hypothesis of equal probability of occurrence on the 5 choice Likert scale, the attitude trends in all 4 cases were pro-CAI (i.e., all 4 X^2's were significant ($p < .01$)). The results also indicated a significant shift in attitudes between Weeks 1 and 2 on both parts of the attitude

Table 4

CAI Group Attitudes

Attitude Measure	N	Part I Mdn/$\bar{X}$	Part I SD	Part II Mdn/$\bar{X}$	Part II SD	Evaluation[1]
Week 1	278	44/42	11	46/47	5	Pro-CAI
Week 2	248[2]	38/35	12	45/45	6	Pro-CAI

[1]Score norms: 55 = Max Pro-CAI
33 = Neutrality
11 = Max Pro-CI

[2]30 S's unavailable for retesting

questionnaire. However, it is equally significant to note that the resultant shift in attitudes was not a complete swing away from favoring the CAI method but only a regression of emphasis on the 5 point Likert scale to a point midway between "favoring" CAI and a "neutral" position toward it and CI. Overall, the average (both median and mean) attitude scores in Table 4 illustrate a moderate stability in the students' attitudes as a group toward CAI despite individual shifts in attitudes between Weeks 1 and 2.

D. Revised vs Feasibility CAI Program

A subsidiary purpose of this study was the comparison of student performance on the revised CAI program with results obtained on the original program developed and used in the feasibility study. The results (Table 5) indicated that the performance of students under the 2 versions of the CAI program were equivalent both with respect to their means and variation.

Although the statistical tests were nonsignificant for both criteria, the extent of the reduction in training time between the original and revised CAI programs was both operationally and administratively significant. Thus, relative to the fixed CI time of 11.25 hours, the CAI program revision resulted in doubling the reduction in training time from 10.8 to 20.1 percent. Operationally, this suggests that program revisions based on student performance records are highly beneficial. The 20.1 percent reduction in training time itself is significant administratively since it meets a preset goal of 20% reduction in training for the effectiveness of CAI at USASCS.

Table 5

Revised vs Feasibility CAI: Achievement/Time

Perform. Measure	Feasibility CAI $\bar{X}$	SD	Revised CAI $\bar{X}$	SD	t[1] $\bar{X}$	F[2] SD
Achiev. (Raw Scores)	60.20	14.40	61.92	13.25	ns[3]	ns
N	(18)		(278)			
Time (Hrs.)	10.03	3.83	8.99	3.02	ns	ns
N	(18)		(278)			

[1]t test: independent means
[2]F test: independent variances
[3]Difference between Feasibility and Revised $\bar{X}$'s: nonsignificant ($p > .01$ level)

Due to the lack of variation in training time in CI (cf. Objective B), the statistical significance of the reduced CAI time in comparison with the fixed CI time of 11.25 hours was restricted to a statement of the raw difference between their means (i.e.,20.1% reduction). However, if desired, an index of the statistical significance of the 20.1% reduction in training time can be derived by comparing the revised CAI mean (8.99) and variability (3.02) with an interpolated mean of 11.25 hours (simulating the CI mean) and standard deviation of 3.00 (typically observed variation). The resultant difference is highly significant ($p < .01$). Thus, while the increased reduction in training time due to the revision in the CAI program was not found to be statistically significant in itself, the overall reduction in training time (20.1%) is considered to be statistically, as well as operationally and administratively, significant.

It should be noted that the necessary program revisions were not so drastic as to violate the integrity of the original CAI package. Thus, although the revised-CAI sample demonstrated improvement both in mean

achievement and completion time (Table 5), the nonsignificance of the differences between it and the feasibility-CAI sample supports the conclusion that the 2 related CAI programs are basically equivalent. Therefore, the underlying purpose of the present study to serve as an approximate replication of the feasibility study was not vitiated.

Summary and Conclusion

The results relating to each of the 4 objectives of this study are summarized as follows:

A. CAI vs CI: Achievement/Time. The 2 study groups were equivalent with respect to their achievement but the CAI group completed their prescribed training (Week 1) in significantly less time. In comparison with the fixed time of 11 1/4 hours of instruction for the CI group, the CAI group's mean time of 8.99 hours represented a 20.1% reduction in training time.

B. CAI vs CI: Follow-up Achievement/Time. Both study groups demonstrated equivalent performance on all 4 follow-up criteria obtained at the end of Week 2 of basic electronics training: written/performance tests and incidence of setbacks/failures.

C. Attitudes toward CAI. The CAI group maintained a favorable disposition toward CAI over an interval of 2 weeks of instruction, despite their taking CI during the second week of training.

D. Revised vs Feasibility CAI Program. The data illustrated the important role which course revision has in the development and application of CAI. The overall reduction of training time of 20.1% was judged to be not only operationally and administratively but statistically significant as well.

The findings completely support the basic conclusion drawn in the feasibility study that CAI is as effective as CI in teaching basic electronics and further demonstrates the capability of CAI to reduce training time to a significant degree.

References

1. Campbell, D. T. Factors relevant to the validity of experiments in social settings. Psychological Bulletin. 1957, 54, 297-312.

2. Hays, W. L. Statistics for psychologists. New York: Holt, Rinehart and Winston, 1963. 719 pp.

3. Mayo, G. D., and Longo, A. A. A note concerning the matched group design. Personnel Psychology. 1968, 21, 241-244.